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Enhanced computer-controlled teletext circuit SAA5243

In the last few years, teletext has become an established feature in the domestic tv market. Over 15 million teletext tv receivers have now been produced, and the teletext facility is considered as a standard requirement for medium and top-range tv sets. As more countries start transmitting teletext, and as the features and quality of the service improve, the demand for teletext receivers will undoubtedly expand.

The Enhanced Computer Controlled Teletext (ECCT) circuit, SAA5243 (Ref.1), is designed to form the heart of a versatile and economical teletext decoder that takes full account of the increasingly complex requirements of the market. For improved recovery of the transmitted teletext data under poor signal conditions, a new video processor (VIP2), the SAA5231 (Ref.2), has been developed for use with the ECCT circuit. While catering for many diverse applications of teletext, these two circuits have been designed so that there are no system cost penalties for the standard mass-market television application.

FEATURES OF THE ECCT

- performs all the digital logic functions of a 625-line World System Teletext decoder
- microcomputer-controlled (via the I^2C bus) for flexibility
- 192 characters (12 x 10 dot matrix)
- covers all the major languages in Western Europe
- automatic selection of English, French, German, Italian, Spanish and Swedish character sets
- field flyback or full-channel data acquisition
- direct interface with up to 8 K bytes static RAM
- handles up to 4 simultaneous page requests
- 25th display row for software-generated messages
- cursor control available for videotex and telesoftware
- 7-bits plus parity, or 8-bit data reception
- accepts extension packets
- single 5 V power supply
- mask-programmable character sets for regions outside Western Europe
- slave sync operation option
- odd/even field output for de-interlaced displays.

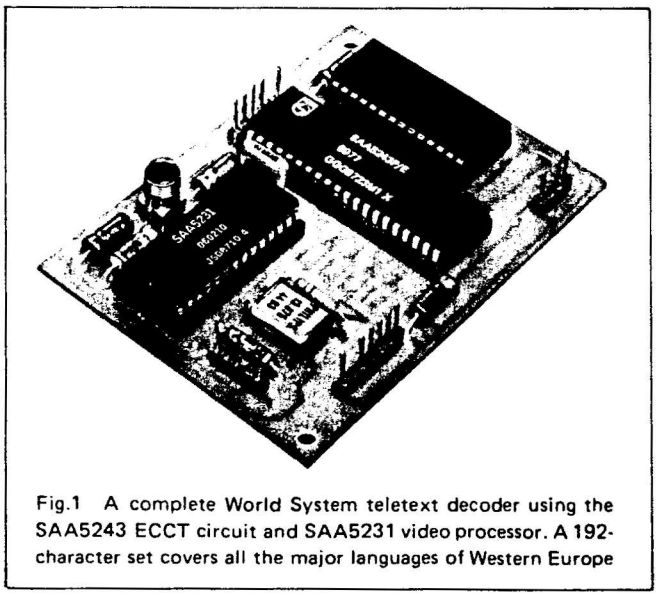

Fig.1 A complete World System teletext decoder using the SAA5243 ECCT circuit and SAA5231 video processor. A 192-character set covers all the major languages of Western Europe

WORLD SYSTEM TELETEXT DEVELOPMENTS

Languages

The World System Teletext standard (Ref.3), previously known as UK Standard Teletext, has now been adopted in more than thirty countries, making the language requirements increasingly complex. Currently, individual languages or small groups of languages are catered for by mask-programmed variants of the character generator circuits of the decoder. Although this has been satisfactory for national broadcasting, the availability of 'national' broadcasts to an international audience via satellite transmissions and the trend towards international broadcasting make it desirable for teletext transmissions to be decoded correctly outside their country of origin. And as broadcasting becomes more international, teletext can be used to subtitle programmes in many languages simultaneously, making them comprehensible to a much wider audience – the desired translation being selected by the viewer and inserted in the normal picture, see Fig.2.

Some languages require many special characters, more than can be accommodated in the standard 96-character sets available with earlier teletext circuits. Spain is the first country in Europe to start a teletext service using an extended set of 128 characters. Other countries, for example Iceland, need a small number of special symbols which cannot be implemented economically in their own circuit variant owing to the relatively small home-market for tv sets. The best solution here is to include the special symbols in a standard device for a large group of languages.

Using a set of 192 characters, the ECCT circuit covers *all* the languages required in Western Europe. When controlled with suitable software, a teletext decoder using the ECCT circuit can be used anywhere in Western Europe with the correct characters displayed automatically.

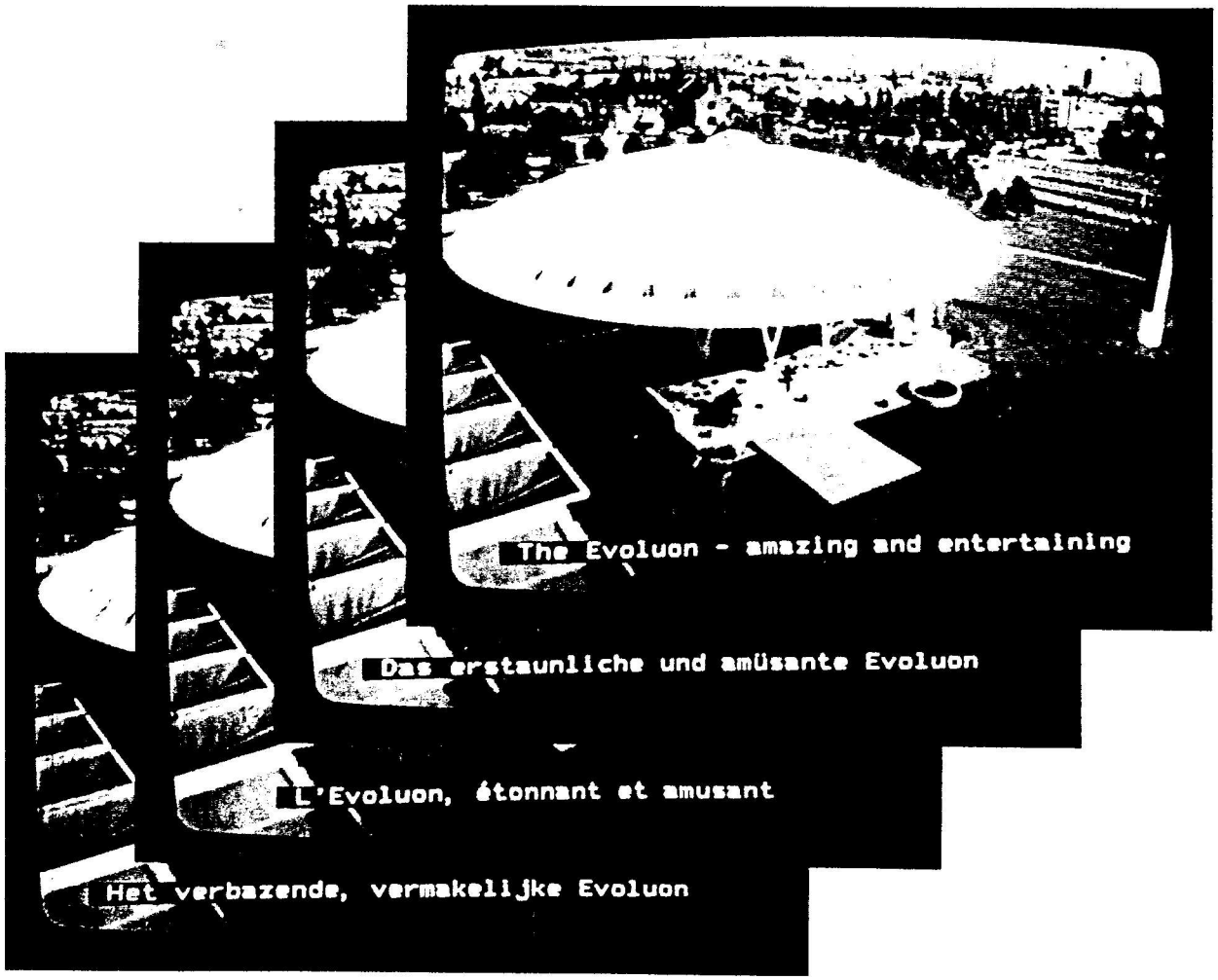
The Evoluon - amazing and entertaining
Das erstaunliche und amüsante Evoluon
L'Evoluon, étonnant et amusant
Het verbazende, vermakelijke Evoluon

Fig.2 Multi-language subtitling makes more programmes comprehensible to today's international television audience

FLOF/Fastext

As teletext services mature, new features are being introduced to make it easier for the viewer to select the required information. A system known as FLOF (Full Level One Features) or Fastext (Ref.4) is now in service in the UK and Spain, with other countries expected to follow shortly. This gives easy selection of pages via coloured keywords (prompts) at the bottom of the screen which are used in conjunction with corresponding coloured keys on the remote control unit, see Fig.3. Instant access to pages can be provided by using additional memory. The ECCT circuit has all the facilities necessary to implement a Fastext decoder economically – multiple acquisition circuits, extension packet capture and a display row for broadcaster-generated prompt messages.

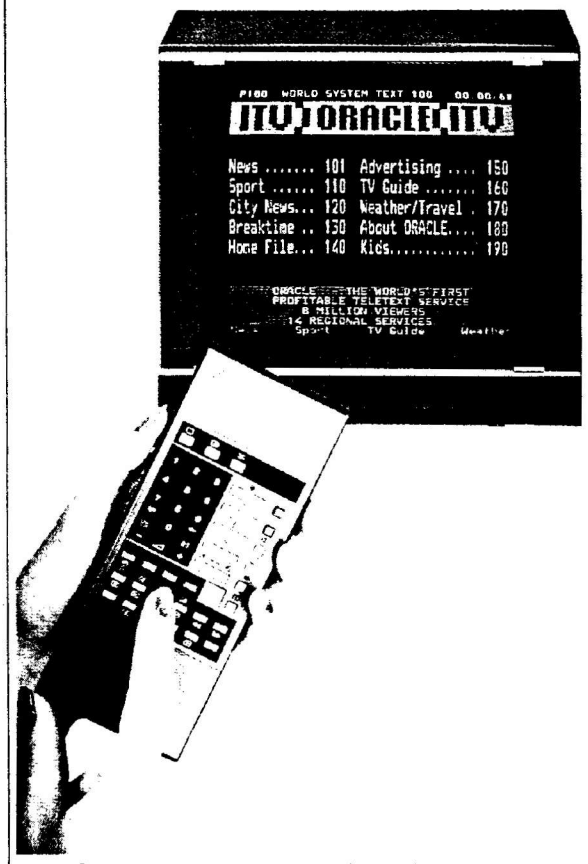
P100 WORLD SYSTEM TEXT 100
ITV ORACLE ITV
News ..... 101 Advertising 150
Sport ..... 110 TV Guide 160
City News... 120 Weather/Travel . 170
Breaktime .. 130 About ORACLE.... 180
Home File... 140 Kids..... 190
ORACLE THE WORLD'S FIRST
PROFITABLE TELETEXT SERVICE
8 MILLION VIEWERS
14 REGIONAL SERVICES
Sport TV Guide Weather

Fig.3 Full Level One Features (FLOF) or Fastext decoders using the ECCT simplify page selection and can provide instant page-access

VCR control

Another area of expansion for teletext is in the programming of VCRs. Such a programming system uses teletext pages containing programme schedules. The user selects the programmes to be recorded by moving a cursor on the screen to the required programme and pressing a "record this" button. This causes the necessary information to be loaded into the VCR automatically and the programme will be recorded when it is broadcast. In Germany, this system is known as VPV (Videotext Programmiert Videoheimgeräte), and a VPV decoder can be built using the ECCT circuit with suitable software to download the programme recording data into the VCR control circuit. The signals that switch the VCR recording circuits on and off are broadcast using the Video Programming System (VPS) format, so a VPS circuit is still needed to control the VCR. However, the necessary functions are now included in the broadcast teletext specification (Ref.3), which may be adopted in other countries. In this case, both the programming and control of the VCR could be performed with the ECCT and suitable software.

Data distribution

As well as these mass-market consumer applications, there is increasing interest in the use of teletext for data distribution. Subscription teletext services (for example, specialised financial information, control data and racing results) make use of teletext transmissions to convey data, and are not intended to be received on a normal teletext tv set. A degree of security can be achieved using encryption and access control methods, so that only those entitled to receive the data can do so. Decoders for such services (using the 'page format' transmission method) can be built using the ECCT with suitable software.

Another professional application for teletext technology is the distribution of data within an office or factory. Here, teletext is not broadcast, but is relayed through coaxial cable. Such systems can make use of full channel teletext data, where the entire channel is used for teletext and there is no accompanying tv picture signal. This allows a high data throughput of over 600 pages per second, giving fast access. These methods are particularly useful when a large number of receiving terminals are envisaged, since a full-channel teletext data inserter need occupy only one port on a computer, however many terminals are served. The ECCT can be switched (under software control) to accept full-channel teletext, with data inserted on any tv line.

Although a variety of applications can be catered for, the design of the ECCT circuit and VIP2 ensures there is no cost penalty for the normal mass-market application. In the design of the ECCT-based teletext decoder, two types of function have been distinguished:

- standard functions fixed by the broadcast specifications, for example, data slicing, sync generation and data acquisition – performed by dedicated circuitry in the VIP2 and the ECCT.

– functions that will vary depending on the application, for example, the control functions and displayed languages – performed by software in the decoder's control microcomputer.

Advanced decoders for professional applications are made mainly by using more sophisticated software than that used in decoders for the mass-market; often no hardware changes are required.

WORLD SYSTEM TELETEXT DECODER USING ECCT

Hardware

A simple World System teletext decoder using the ECCT is shown in Fig.1. It consists of three ICs and a few peripheral components. From the incoming composite video signal, the video processor extracts the teletext data, regenerates the teletext clock and produces the signal for synchronizing the text display to the tv syncs. The ECCT provides all the necessary digital hardware functions for a teletext decoder.

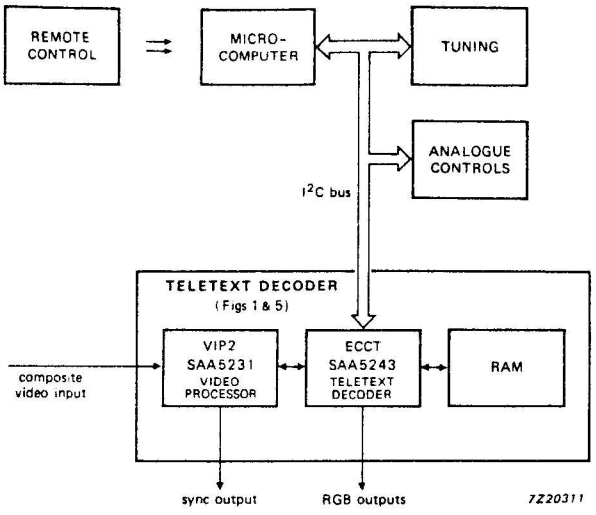

Fig.4 Integrated teletext decoder control

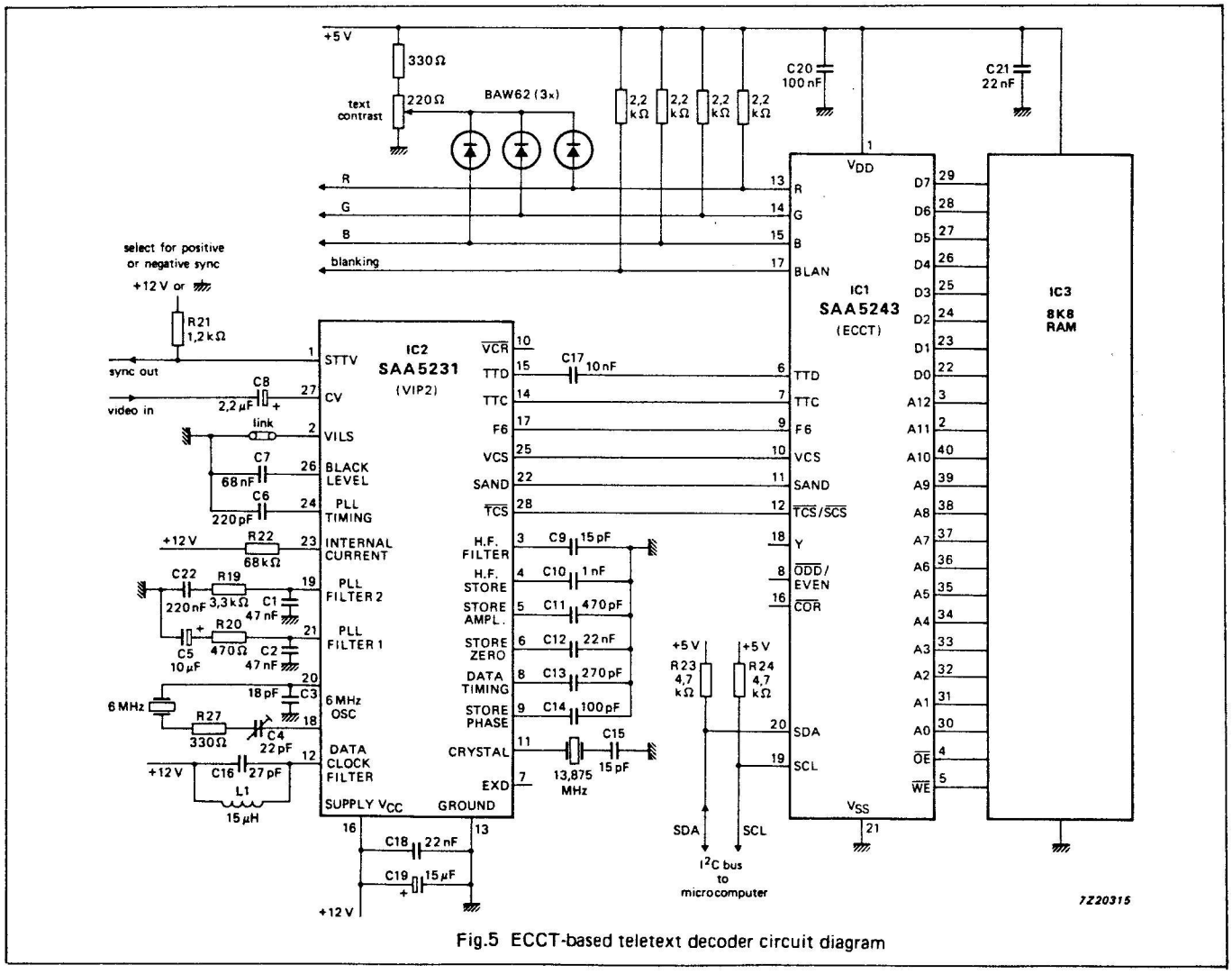

Fig.5 ECCT-based teletext decoder circuit diagram

It interfaces to a standard static RAM (typically 8 K byte) used as page memory.

As can be seen from Fig.1, this standard form of teletext decoder is small enough to be located on the main circuit board of a tv set – an approach that is becoming fairly common as teletext becomes a standard feature of a tv set. Putting the decoder on the main board eliminates the connectors, wiring and brackets of the conventional 'add-on' teletext decoder, and with careful board design, some of the peripheral components such as output buffers can be eliminated too. The ECCT is controlled via the 2-wire I^2C bus by the tv set's microcomputer, which, in addition, decodes signals from the remote control, and controls the tuning and analogue functions. In this approach, see Fig.4, the teletext facility is clearly designed as an integral part of the tv set. The circuit diagram of the complete teletext decoder is shown in Fig.5.

For more sophisticated systems, or where a variety of options are required in the tv set design, a modular approach may be preferred, see Fig.6. Here, a microcomputer is dedicated to the control of the teletext decoder, allowing higher performance with more independence from the rest of the set design. The hardware of the decoder itself is identical to that shown in Fig.5. This approach provides flexibility in design – modules for teletext, videotext and subscription teletext can be added as required (as long as the remote control decoding software can pass on all the necessary commands).

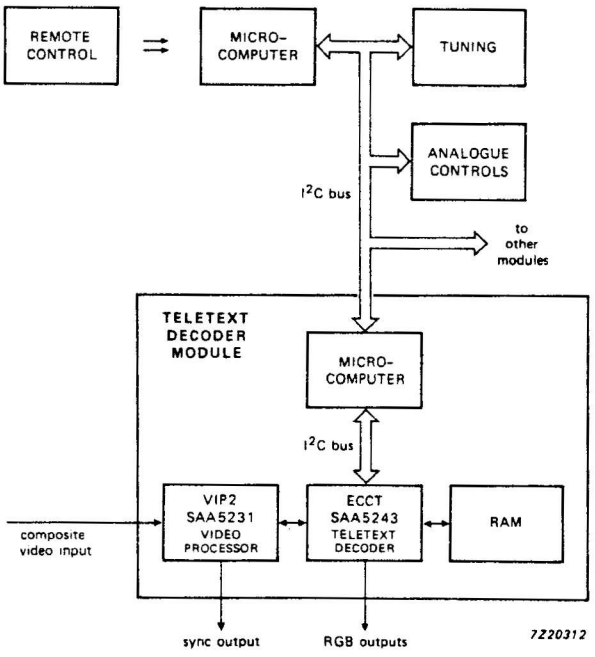

Fig.6 Modular teletext decoder control

Video Processor (VIP2): SAA5231

The SAA5231 is a 28-pin bipolar linear IC (see Fig.7) which extracts the teletext data from the composite video, regenerates the clock and synchronizes the text display to the tv syncs.

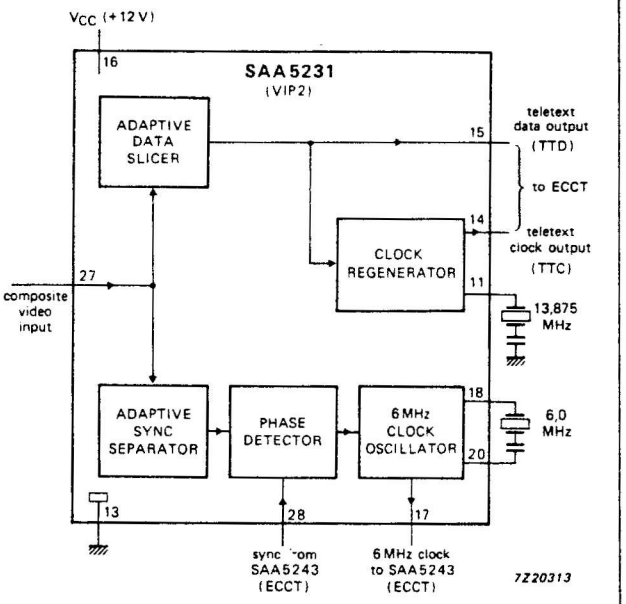

Fig.7 Video input processor SAA5231 (VIP2). Only the main functions are shown

The data detector of the VIP2 finds the slicing level for extracting the teletext data and compares it with the composite video to obtain sliced data. The slicing level is automatically altered to suit variations in data amplitude and low-frequency disturbances such as co-channel interference, while remaining relatively unaffected by echoes, data content, and noise. High-frequency losses in the signal are compensated, if necessary, to enlarge the "eye height" for improved data reception.

The teletext clock generator takes in the sliced data and generates a synchronized clock derived from a free-running crystal oscillator whose phase is shifted in a feedback loop until it is at the optimum point for latching the data. A PLL is not used as it would take too long to lock in; the circuit used can find the correct clock phase before the end of the clock run-in period. This type of regenerator produces less jitter than a tuned circuit and has no critically-adjusted components. In addition, missed clock cycles can't cause a loss of bit synchronization.

The 6 MHz clock for the character display is derived from a VCO. This clock is part of a PLL required to synchronize the teletext characters to the video signal; the PLL has been designed to allow the display to be locked to a VCR, for status messages, for example. The VIP2 includes a wide range adaptive sync separator for this PLL.

Enhanced computer-controlled teletext (ECCT) circuit: SAA5243

The SAA5243, see Fig.8, is a 40-pin NMOS IC which performs all the digital logic functions of a 625-line World System Teletext decoder. Serial data and clock signals from the VIP2 video processor enter on the TTD and TTC pins respectively. After data capture, the data enters the page memory via a memory interface also used to direct data from the RAM to the character generator as required. The character generator provides the RGB drives for the video stages of the tv receiver or monitor. Outputs are provided for blanking and contrast reduction of the tv picture (BLAN and $\overline{COR}$), together with a monochrome text signal (Y) for driving a printer.

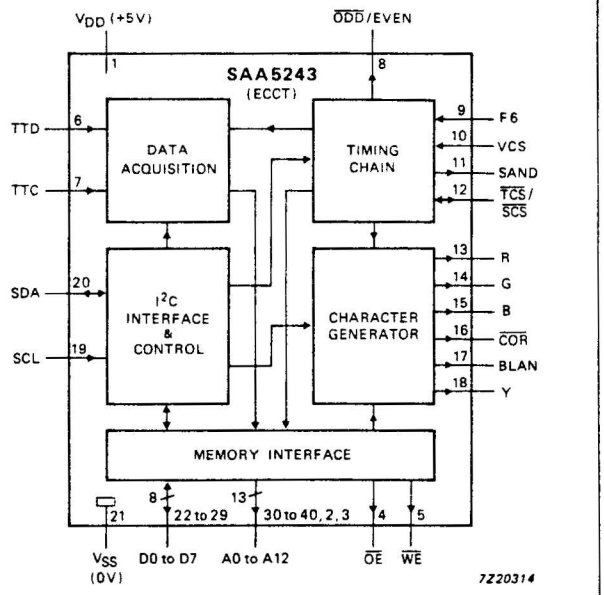

Fig.8 Enhanced Computer Controlled Teletext circuit (ECCT)

Timing chain

Timing signals for all of the ECCT are provided by the timing chain circuitry, which operates from a 6 MHz clock F6 from the VIP2. Line synchronization with the incoming signal is performed by a phase-locked oscillator in the VIP2, using the reference signal SAND from the ECCT. A composite sync waveform, VCS, from the VIP2 provides field synchronization for the data acquisition timing and also for the display timing when interlaced display is selected. The display timing circuit generates a composite sync waveform, TCS (with interlaced or non-interlaced format), used to drive the display timebases via the VIP2; alternatively, this pin can act as an input for a composite sync waveform to 'slave' the display timing circuits in the ECCT. To summarize, the main features of the timing chain circuitry include:

- operation from an external clock from VIP2
- display format – 625 lines/25 rows/10 lines per row
- can generate interlaced or non-interlaced (312/312 or 312/313 lines) composite sync
- double-height characters can be selected by the viewer
- software control of data entry period for normal field flyback and full-channel transmissions
- internal field sync integrator
- internal signal quality detector
- odd/even field output for de-interlacing circuits.

Data acquisition

The data acquisition section is enabled by a signal from the timing chain during lines 2 to 22 inclusive for field-flyback transmissions, or during all lines for full-channel transmissions. Serial data from the VIP2 is clocked into the TTD (TeleText Data) pin with the 6.9375 MHz TeleText Clock (TTC). The serial data stream is converted to 8-bit wide parallel data bytes, and a byte counter keeps track of the incoming data and allocates it to the correct function.

The data acquisition section can search for, store in memory and continuously update four pages simultaneously because there are four different acquisition circuits. If no extension packet processing is required, up to eight pages may be stored, although only four of them are continuously updated.

Each teletext page is numbered using seven digits – one for magazine, two for page number and four for sub-pages (rolling pages). The ECCT's acquisition circuits can receive pages by checking any combination of these seven digits, ignoring those not required by using a 'don't care' facility. Besides decimal page numbers for use with conventional teletext broadcasts, the full hexadecimal range of page numbers can be requested for maximum flexibility in specialized data distribution systems.

The main features of the data acquisition section are:

- accepts standard World System Teletext transmissions
- automatic selection of national character sets by decoding bits C12, C13, and C14 of the page header
- accepts up to 25 extension packets for processing by the control microcomputer. In this mode, each page requires 2 K bytes of memory, giving a maximum of 4 pages
- receives the following extension packets: X/24, X/25, X/26/0 to X/26/14, X/27/0, X/27/1, X/27/4, X/27/5, X/28/0, X/28/1, X/28/2, X/30
- can pass all transmitted control bits and addresses to a microcomputer for interpretation
- up to 4 simultaneous page requests are allowed in either field-flyback or full-channel mode
- software selection of field-flyback or full-channel data operation

- 'don't care' facility is available on magazine, page, and sub-code digits
- in field-flyback mode, automatic clearing of old page on first reception of new page, and clearing when page header bit C4 is set
- in full-channel mode, the clear functions are not available so pages should be transmitted non-row-adaptively
- central part of the page header rolls, in green, when the page in the display chapter is being looked for
- broadcast (rolling) time is always directed to the display memory
- 8-bit data reception option on all rows (for example, tele-software), or normal 7-bits plus parity (under software control)
- acquisition function may be switched off under software control.

Character generator

The ROM in the ECCT contains 192 characters, see Fig.9, each stored as a matrix of 12 dots horizontally and 10 dots vertically, improving legibility and display appearance compared with earlier circuits. The 192 characters are selected

BITS b_4 b_3 b_2 b_1	row	column 0	1	2	2a	3	3a	4	5	6	6a	7	7a	8	9	12	13	14	15
b_8		0	0	0 or 1		0 or 1		0	0	0		0		1	1	1	1	1	1
b_7		0	0	0		0		1	1	1		1		0	0	0	0	1	1
b_6		0	0	1		1		0	0	1		1		0	0	0	1	0	1
b_5		0	1	0		1		0	1	0		1		0	1	0	1	0	1
0 0 0 0	0	alpha-numerics black	graphics black																
0 0 0 1	1	alpha-numerics red	graphics red																
0 0 1 0	2	alpha-numerics green	graphics green																
0 0 1 1	3	alpha-numerics yellow	graphics yellow																
0 1 0 0	4	alpha-numerics blue	graphics blue																
0 1 0 1	5	alpha-numerics magenta	graphics magenta																
0 1 1 0	6	alpha-numerics cyan	graphics cyan																
0 1 1 1	7	alpha-numerics white **	graphics white																
1 0 0 0	8	flash	conceal display																
1 0 0 1	9	steady **	contiguous graphics **																
1 0 1 0	10	end box **	separated graphics																
1 0 1 1	11	start box	ESC *																
1 1 0 0	12	normal height **	black background **																
1 1 0 1	13	double height	new background																
1 1 1 0	14	SO *	hold graphics																
1 1 1 1	15	SI *	release graphics **																

* These control characters are reserved for compatibility with other data codes
** These control characters are presumed before each row begins

Fig.9 The ECCT code table

7Z96828.1

by character address decoding and the ten tv lines by ROM line address decoding. The ROM is accessed once per microsecond providing 12 outputs corresponding to the 12 dots in each line of a character. A 64 μs rate signal from the timing chain clocks a lines-per-row counter, which divides by ten (except when double-height characters are selected). The counter output is used to select the appropriate line of 12 dots in the ROM.

The outputs from the character generator for driving the video stages are R (red), G (green) and B (blue), pins 13, 14 and 15 respectively. The Y output (pin 18) is for controlling a printer and is active for the character foreground only, regardless of colours, and does not contain the flashing function. Blanking signals for the tv picture are supplied through the BLAN pin which is combined character, box, and full-screen blanking. Pin 16 ($\overline{\text{COR}}$) allows selective contrast reduction of the tv picture to enhance a mixed-mode display. All the character generator output pins are open-drain, making many different interfacing arrangements possible.

The main features of the character generator are:

- 12 x 10 dot matrix characters
- interlaced or non-interlaced display (software-controlled)
- serial attributes only
- 192 alphanumeric characters
- 6 national option character sets (English, German, Swedish, Italian, French and Spanish)
- 31-location auxiliary character set
- with suitable control software, all the major languages in Western Europe are covered
- Y output is foreground colour only
- BLAN output is combined character, box, and full-screen blanking
- $\overline{\text{COR}}$ output allows contrast reduction for superimpose or boxes (software controlled)
- user-selectable double height characters under software control. Large characters are then displayed quadruple-height
- double-height characters inhibited in row 23
- separate status row, always in single height, is available for software-generated messages. This may be displayed at the top or bottom of the screen (under software control)
- decoding for black foreground colour is provided
- internal cursor inverts background and foreground colours. It may be made to flash using a software loop in the control microcomputer.

Memory interface

The memory interface has 8 parallel data input/outputs (D0 to D7) and 13 address outputs (A0 to A12) which interface up to 8 K bytes of static RAM. The reading and writing of data to the RAM is controlled by the $\overline{\text{OE}}$ (output enable) and $\overline{\text{WE}}$ (write enable) signals. The RAM cycle is 500 ns with, in general, one write and one read cycle every microsecond. To summarize, the main features of the memory interface include:

- interface directly to 8 K RAM providing up to 8 stored pages in normal mode or 4 stored pages in extension packet mode
- 500 ns memory cycle time
- timings for static RAMs only, 200 ns access time is sufficient
- I^2C bus can address any RAM location for reading and writing
- address converter from row or column to 10 bits is included and addresses all 1024 locations
- all memory automatically cleared to 'space' at power-on
- separate address counters for display, data acquisition, and I^2C bus. I^2C bus address counters allow incrementing and presetting
- RAM locations not used for display or data acquisition purposes are available for use by the control microcomputer
- all RAM accesses (display, acquisition and I^2C bus) are synchronous with system clock
- all pages can be cleared, one at a time, under software control.

I^2C bus interface and control

The I^2C bus and control section are used to control the variable functions of the ECCT directly by altering the mode register bits, or indirectly via the external page memory. The I^2C bus slave transceiver accepts commands from the control microcomputer via the SDA (serial data) and SCL (serial clock) pins.

A command to one of the ECCT's mode registers follows the normal I^2C bus protocol (see Ref.5). The first byte contains the ECCT's slave address (0010001), with the R/W bit set to 0 to indicate 'write'. The second byte is interpreted as the register address required (R1 to R11), and the third byte is data to be loaded into that register. Subsequent bytes in the same I^2C transmission can be interpreted as data for the following register because the register address auto-increments. The register map for the ECCT is shown in Fig.10, with auto-increment being indicated by the arrows on the right of the diagram. The auto-increment allows several conditions to be set up by just one I^2C bus transmission. Register 11 is the address for accessing the external page memory. It is read/write as any

		D7	D6	D5	D4	D3	D2	D1	D0
Operating mode	R1	TA	$\overline{7+P}$/ 8 BIT	ACQ. $\overline{ON}$/OFF	EXTENSION PACKET ENABLE	$\overline{DEW}$/ FULL FIELD	TCS ON	T1	T0
Page request address	R2	–	BANK SELECT A2	ACQ. CCT A1	ACQ. CCT A0	TB	START COLUMN SC2	START COLUMN SC1	START COLUMN SC0
Page request data	R3	–	–	–	PRD4	PRD3	PRD2	PRD1	PRD0
Display chapter	R4	–	–	–	–	–	A2	A1	A0
Display control (normal)	R5	BKGND OUT	BKGND IN	COR OUT	COR IN	TEXT OUT	TEXT IN	PON OUT	PON IN
Display control (newsflash/subtitle)	R6	BKGND OUT	BKGND IN	COR OUT	COR IN	TEXT OUT	TEXT IN	PON OUT	PON IN
Display mode	R7	STATUS ROW $\overline{BTM}$/TOP	CURSOR ON	$\overline{CONCEAL}$/ REVEAL	$\overline{TOP}$/ BOTTOM	$\overline{SINGLE}$/ DOUBLE HEIGHT	BOX ON 24	BOX ON 1-23	BOX ON 0
Active chapter	R8	–	–	–	–	CLEAR MEM.	A2	A1	A0
Active row	R9	–	–	–	R4	R3	R2	R1	R0
Active column	R10	–	–	C5	C4	C3	C2	C1	C0
Active data	R11	D7 (R/W)	D6 (R/W)	D5 (R/W)	D4 (R/W)	D3 (R/W)	D2 (R/W)	D1 (R/W)	D0 (R/W)

Fig.10 Register map of the ECCT. The arrows shown on the register map indicate that the register address auto-increments on the following I^2C transmission byte. TA (in register R1) and TB (in register R2) must be logic 0 for normal operation. All bits in registers R1 to R10 are cleared to logic 0 on power-up except bits D0 and D1 of registers R5 and R6 which are set to logic 1. All memory is cleared to 'space' (00100000) on power-up, except row 0 column 7 chapter 0, which is 'alpha white' (00000111) as the acquisition circuit is enabled but all pages are on hold

RAM location can be read as well as written by the control software. All other registers are write only. The register bits have the following functions:

Register R1: Operating mode

D0, D1	interlace/non-interlace 312/313 line control
D2	text composite sync or direct sync select
D3	field-flyback or full-channel mode select
D4	extension packet enable
D5	data acquisition circuit enable/disable
D6	data reception select: 7-bit with parity check or 8-bit
D7	should be 0 for normal operation.

Regiser R2: Page request address

D0, D1, D2	defines the start column for page request data
D3	should be 0 for normal operation
D4, D5	selects one of four acquisition circuits
D6	selects the bank of 4 pages being addressed for acquisition.

Register R3: Page request data

D0 to D4	contains four groups of data (one for each acquisition circuit), allowing four simultaneous page requests, see Fig.11.

Register R4: Display chapter

D0, D1, D2	determines which of 8 pages is displayed.

Register R5 (normal) and R6 (newsflash/subtitle): Display control

D0, D1	picture on: inside (D0) and outside (D1) the boxed area
D2, D3	text on: inside (D2) and outside (D3) the boxed area
D4, D5	contrast reduction on: inside (D4) and outside (D5) the boxed area
D6, D7	background colour on: inside (D6) and outside (D7) the boxed area.

Start Column	PRD4	PRD3	PRD2	PRD2	PRD0
0	Do care Magazine	$\overline{\text{HOLD}}$	MAG2	MAG1	MAG0
1	Do care Page tens	PT3	PT2	PT1	PT0
2	Do care Page units	PU3	PU2	PU1	PU0
3	Do care Hours tens	X	X	HT1	HT0
4	Do care Hours units	HU3	HU2	HU1	HU0
5	Do care Minutes tens	X	MT2	MT1	MT0
6	Do care Minutes units	MU3	MU2	MU1	MU0

X: bit not used.

Abbreviations:

MAG	magazine	page number
PU	page units	
PT	page tens	
MU	minutes units	page sub-code
MT	minutes tens	
HU	hours units	
HT	hours tens	

Fig.11 Register map for page requests. Register R3 contains four groups of data (one for each acquisition circuit) allowing four simultaneous page requests. The columns auto-increment on receipt of successive I^2C transmission bytes. When the DO CARE bit (PRD4) is set to 1, the corresponding digit for each group is taken into account for page requests. If the DO CARE bit is set to 0, each digit is ignored. This allows, for example, 'normal' or 'timed page' selection. If $\overline{\text{HOLD}}$ is set to 0, the page is held and not updated

Register R7: Display mode

D0, D1, D2	boxing function allowed on: row 0 (D0), rows 1 to 23 (D1), row 24 (D2)
D3	selects single or double height characters
D4	selects the top or bottom parts of the display
D5	used to reveal concealed areas of text
D6	cursor enable for reversing background and foreground colours
D7	determines whether row 25 is displayed below or above the main text.

Registers R8 to R11: Active chapter, row, column data

Registers R8 to R11 contain active chapter, row, column, and data information written to or read from the page memory via the I^2C bus.

To recap, the main features of the interface are:

- standard I^2C bus slave transceiver
- operates from 0 to 100 kHz
- acknowledge function
- position registers (R9 and R10) auto-increment after certain commands or may be directly addressed
- auto-increment between certain command registers as well as direct addressing
- all RAM locations accessible via the I^2C bus for reading and writing.

Software

The hardware of an ECCT-based teletext decoder is similar for many applications; it is the control software which determines the operating characteristics of the decoder, from the simplest stand-alone single-page decoder to a sophisticated multi-page decoder fully integrated into the design of the tv set. Software can interact with the programmable mode register bits in the ECCT or with the contents of the page memories. The I^2C bus interface allows the ECCT to be controlled by one microcomputer (as in Fig.4) or, in more complex systems, by several microcomputers, each performing a defined set of tasks (as in Fig.6). Other devices can be connected to the I^2C bus, depending on the facilities required, e.g. non-volatile memory, clock/calendar circuit, display driver, switching circuits, analogue control circuits. The way in which these devices are used depends entirely on the control software.

Many setmakers will prefer to write their own software to satisfy their own requirements. This also provides the opportunity to make a set different from that of other manufacturers. However, for those wishing to avoid the development costs of a custom design, a range of software packages for the ECCT is available.

Whatever the design of a decoder, the software is responsible for interpreting the commands from the remote control handset and controlling the corresponding ECCT registers in the desired way. For example, a control for double-height text may be desired. This could be implemented using three

buttons on the handset: 'large top', 'large bottom' and 'small'. Alternatively two buttons 'large' and 'small' could be used, with the 'large' command alternating between a 'large top' and 'large bottom' display. Another possibility would be to have only one button, giving sequentially 'large top', 'large bottom' and 'small' as a three-way toggle function. By writing the appropriate control software, the designer can make the ECCT operate in any of these ways.

In the simplest decoder, the control software deals with such functions and with requests for pages. It is also necessary to inform the user what is happening, so on-screen status messages must be generated, e.g. the requested page number, or the HOLD function. Within the constraints of the display, any message can be produced with appropriate software.

In the simplest decoder, only one page would be searched for at a time and only one acquisition circuit in the ECCT would be used. However, with the cost of standard RAM devices continuing to fall, a multi-page decoder giving the possibility of instant page access may be only marginally more expensive than a single-page decoder.

There are many ways of deciding which pages to capture, and again this function is set by the control software. For example, a user could store 'preferred' page numbers in non-volatile memory and request them in sequence by a 'next page' button. Another possibility would be for the broadcaster to determine which pages are associated with a given page, and to communicate this to the decoder by the 'linked page' extension packets (packets X/27). The decoder software can then read the associated page information from the ECCT memory, and make the appropriate page requests. Used in conjunction with an extra display row and coloured keys on the remote controller, this technique gives the FLOF/Fastext service now coming into operation in several countries.

As indicated earlier, the SAA5243E can display all the characters required for the major languages of Western Europe (Fig.12). Decoders for the more complex languages in Western Europe will require additional character-processing software. In some countries, extension packets X/26 are used to give supplementary characters, or to add accents to letters using the 'composition coding' technique. The X/26 packet information is received by the ECCT and stored in the extension packet area of page memory. Control software must read this data, interpret it and address the correct character via a software look-up table. This technique allows for many more languages than the English, German, Swedish, Italian and French national-option character sets selected automatically by the ECCT. With correct software, the following additional languages can be accommodated: Basque, Catalan, Danish, Faroese, Frisian, Gaelic, Greenlandic, Icelandic, Ladin, Portugese, Spanish and Welsh. These additional languages all rely on composition coding or supplementary characters transmitted via packets X/26 and will not be received correctly without the correct character processing software. Some other languages, such as Dutch, Finnish and Norwegian, use only the normal characters of a national option set and will be received correctly without character processing software.

For applications such as subscription teletext, telesoftware, VCR programming and videotex, clearly the software *and* the peripheral hardware of an ECCT-based decoder will have to be modified. For example, more memory, more powerful microcomputers and different interfacing to the decoder will usually be required compared with those for the mass-market application. Although designed for the consumer market, the price of enhanced computer-controlled teletext makes it attractive for other applications even when all its facilities are not used. For example, a simple VDU terminal could be constructed using the character generator without using the acquisition circuits. Or a high speed data distribution system for broadcast or cable networks could be provided using the acquisition circuits, without using the character generator.

Fig.12 All the characters required for the major languages of Western Europe can be displayed using the ECCT

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